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Energy in Agriculture: Energy Resource Series for Youth and Adult Energy Programs: 3. Oil and Gas

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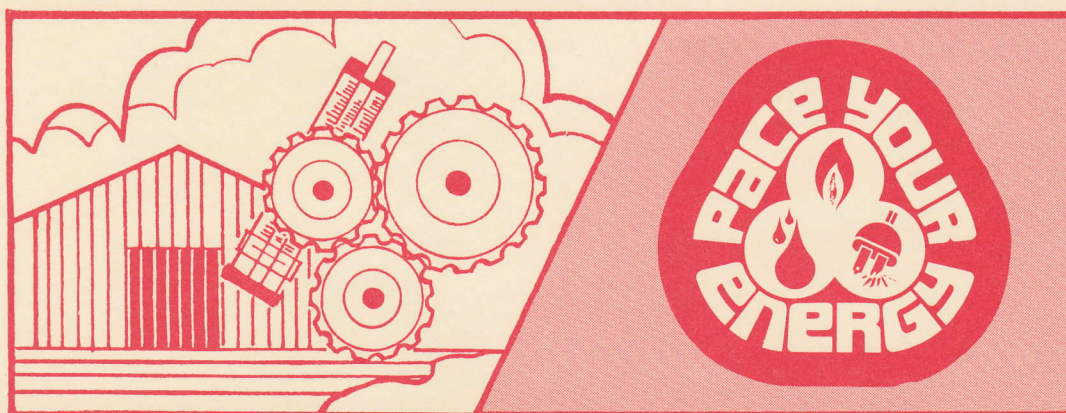
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ENERGY IN AGRICULTURE

Energy Resource Series for Youth and Adult Energy Programs

3. *Oil and Gas*

by
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Preface

The closest contact most of us have with the oil and gas industry is pumping gas at the local filling station or paying home fuel bills. What we often don't realize is that locating fossil fuel deposits in the earth and bringing them to the consumer is an extremely complicated industry. In this publication we'll take a brief look at all segments of this part of the national energy program.

This publication is the third in a 12-part energy resource series designed for the adult and student with a serious interest in the energy situation. Each publication examines a different energy source and considers the advantages and disadvantages associated with its use.

When necessary, diagrams and/or tables are used to clarify or elaborate upon information found in the text. Questions with answers are included at the end of each publication so that you can test what you have learned.

The author wishes to thank Joseph Taraba and Linda Bach of the Department of Agricultural Engineering, University of Kentucky, for reviewing the text.

The Energy Resource Series for Youth and Adult Energy Programs includes the following publications:

- AEES-21 Energy Overview
- AEES-22 Definitions
- AEES-23 Oil and Gas
- AEES-24 Coal
- AEES-25 Solar
- AEES-26 Wind
- AEES-27 Nuclear Fission
- AEES-28 Nuclear Fusion
- AEES-29 Wood
- AEES-30 Water
- AEES-31 Geothermal
- AEES-32 Alcohol

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Energy Resource Series for Youth and Adult Energy Programs

3. Oil and Gas

The Origin of Oil and Gas

The oil and gas in the earth today were formed many millions of years ago, long before humans appeared on the scene. Therefore, man can only theorize about the origin of these fossil fuels.

The most widely accepted theory is that the oil and gas found in the earth today had their beginnings in decomposed animals and plants. The decomposition was caused by bacteria and chemicals called enzymes which digested the plant and animal bodies.

The common by-products of this decomposition are water (H_2O), ammonia (NH_3), hydrogen sulfide (H_2S), methane (CH_4) and carbon dioxide (CO_2). It is the methane or natural gas that is useful to us today. Natural gas is being formed continually in the form of marsh and sewer gas from anything that rots or decomposes. However, these quantities are relatively scanty, widespread and of little use to us today.

The theory asserts that extremely lush growth of fern-like plants and great numbers of animals, both large and small, were very quickly covered by upheavals of the earth's crust. This action was probably caused by gigantic volcanic eruptions. There is evidence of large mammoths fossilized with a mouth full of plants, ready to chew and swallow, indicating rapid and unexpected burial by the upheaval.

Plants and animals are organic substances; therefore, they will decompose. But, if not protected, the results or by-products of decomposition will be swept away by wind and water, leaving very little of the original organic substance concentrated in the area. What happened in the past is quite similar to what farmers do today to preserve a healthy crop of green feed, such as corn or alfalfa. They preserve it by putting it in a silo.

A silo is a large, sealed structure. Bacteria are always present on living (organic) substances. When the life cycle of a plant or animal is interrupted, the bacteria, which have been held at bay by the living plant or animal cells, gain the upper hand and start consuming the organic material. In the silo some of the by-products cannot escape, and the

bacteria themselves begin to die off since they can't live in their own by-product. Thus, the decomposition process ceases. This might be likened to preserving by pickling.

A similar situation occurred when the living plants and animals were quickly buried. The bacteria could decompose the organic remains but the by-products, sealed under great layers of earth, were preserved for millions of years.

We must remember that it is not the bacterial decomposition that creates the energy. This action is simply the preservation or storage of it. The buildup or input of energy originally came from sunlight through photosynthesis.

It is known now that it took two types of events to initiate the formation of oil and gas. First, there was the vast growth of green plants, with the large number of animals feeding on them and second, there was the extremely rapid covering and sealing of this growth to cause preservation. Without these two extraordinary events we would not have the fossil fuel age of today.

There appear to have been numerous occurrences of heavy growth and burial at various times and places on the earth's surface. This is evident since we find fossil fuels—oil, gas and coal—at widely separated places and in layers separated by many feet of earth and rock. The main difference between oil, gas and coal is the much greater amount of animal matter making up oil and gas. We might think of oil and gas being close kin, like brother and sister, while coal is a little more distant kin, like first or second cousins.

The Elements of Oil and Gas

Oil and gas are of the same family, each having organic origins. This organic family is made up of molecules called hydrocarbons; their elemental or atomic makeup consists of carbon and hydrogen atoms.

The preserved, partially decomposed remains of the plants and animals are extremely important to us because they are hydrocarbons and will burn. That's why we call them fuels. When oxygen is

mixed with these fuels and raised to the ignition temperature by a spark or match, the hydrocarbon molecule is broken apart. Oxygen atoms then join the separate carbon atom forming carbon dioxide, and the hydrogen atoms join other oxygen atoms to form water. Energy in the form of heat is given off by these two combinations because the bonding-energy was lower in the hydrocarbon form than in the carbon dioxide or water combination. This heat can be used for many purposes, such as heating homes or water, cooking or driving pistons in engines.

The Search for Deposits

The fact that these fuels have been preserved by being buried beneath hundreds and even many thousands of feet of earth and rock has been a blessing as well as a curse. The good part is that the quality of the fuel has been kept quite high; the bad part is that it is extremely difficult to locate the exact position of these preserved fuels and, when located, it is extremely difficult to bring them to the surface.

People who work at locating these fuels are highly skilled scientists known as oil geologists and geophysicists. These scientists know the kind of rock formations and strata that are likely to contain oil and gas. They then concentrate their efforts at these locations. Oil and gas are found, in large, economically useful quantities, only in sedimentary rock formations. Sedimentary rock includes limestone, sandstone and shale. Limestone comes from remains, such as the shells of single-cell animals and shellfish, and the skeletons of both very small and large animals. Shale and sandstone come from similar deposits transported from other places by water. These deposits then settle out, giving rise to the name sedimentary.

Special instruments are used to help pinpoint likely positions. The gravimeter, seismograph and magnetometer are the most used. However, in certain instances, instruments that measure electrical resistance of the soil and rock, as well as radioactivity are employed to aid in the search for favorable sites.

Porous rock formations, being less dense, cause less gravitational attraction than very dense rock. This can be detected by the gravimeter. This instrument can be set up at many different locations over a large area and will furnish clues as to the potential oil or gas holding capacity or rocks beneath the surface.

Different type rock formations cause varying magnetic field intensities and directions. These changes can be detected by a magnetometer. This instrument is so sensitive it can be suspended below an aircraft by a cable and survey a very large area quickly.

The seismograph method is very precise but is slower and more expensive. The equipment required by this system is more cumbersome, and usually a large crew is involved. At least two vehicles are needed, one the shot truck and the other the recording truck. These vehicles can be separated by many miles, depending on circumstances, with communication between them by radio.

The shot truck sets off a dynamite charge, and the shock vibrations from this miniature earthquake travel out in all directions through the earth and are reflected from rock layers back to the receiving truck. These are recorded on tapes for the geologists to study. This process can be repeated at many different locations, so that a three-dimensional picture of the rock layer beneath the surface is formed. Some modern vehicles use mechanically generated vibrations. This speeds up the process so that much more ground can be covered.

The formations that are favorable to holding gas or oil deposits look something like those shown in Figures 1 and 2. There are many other formations that scientists know offer possibilities, but these two are typical. Often oil and gas are found together because they are from the same original materials that, when decomposed, form hydrocarbons.

If the records of the instruments show favorable signs at a certain location, the geologists will report that drilling at this location could result in finding oil or gas. There is no way they can be 100 percent certain, short of actual drilling.

Oil, as it is found in its natural state, has been given the descriptive name of crude. This word means that the material is in the natural, unprocessed state. All crude oil does not look the same. It may be colorless or a deep, pitch-black. It can range from rather bright yellow through brown to a green color. The crude may be thin and flow like water or be thick like cold molasses and cause great difficulty with pumps and pipes.

Natural gas may be found close by, even mixed in the crude, or it can be collected in isolated places. During the decomposition, the by-product of the bacterial digestion produces a natural gas very much like marsh gas or sewer gas, when organic substances are decomposed. This gas very often builds up pressure and forces its way into any open

cavities in the rock formations. When these are tapped by drilling, the gas rushes to the surface.

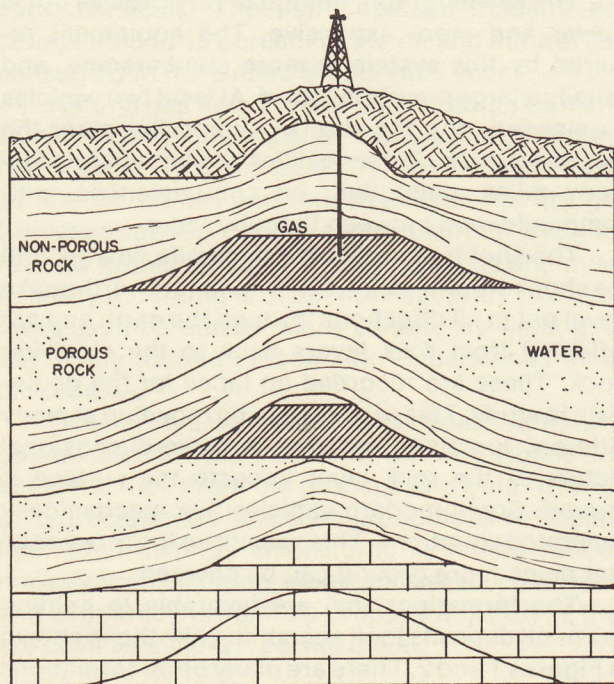


Fig. 1.—A cross section of a portion of the earth's crust showing oil and gas containing strata. The cross-hatched area is oil bearing porous rock with natural gas trapped above it. The lid or cap over the gas is the layer of non-porous rock. The porous rock contains groundwater that must be kept out of the drilled hole by the casing pipe. After drilling several test holes around the area, a scientist usually can outline the location as well as depths to other layers.

Drilling Techniques

The two most common drilling techniques are the cable and rotary methods. However, in recent years directional drilling has come into use. Of the cable and rotary methods, the cable technique is the much older of the two. History records its use thousands of years ago.

Cable Drilling

A diagram of equipment used in cable drilling is shown in Figure 3. A cable drilling rig consists of a small machine with a tower or derrick (F), 10 to 30

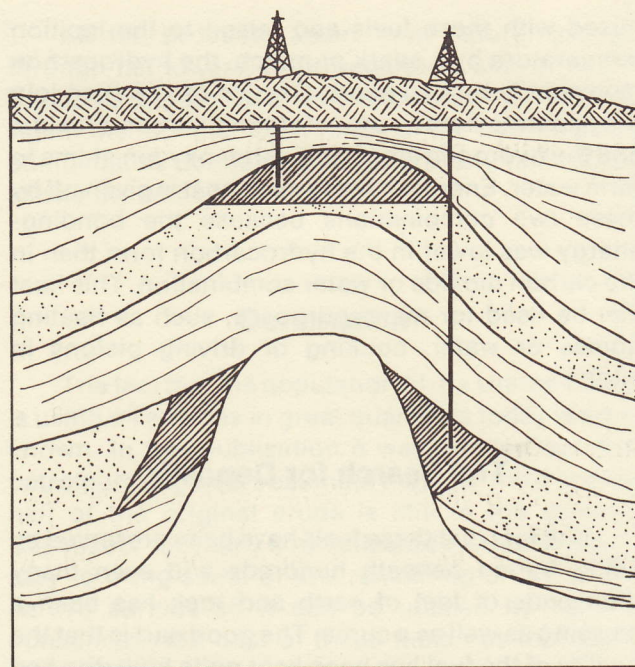


Fig. 2.—Hidden sources of oil and gas are trapped beneath one or more layers of impervious rock which form a lid. By drilling a series of holes around the area scientists can locate and map the potential area. The oil does not lie in pools but is retained in minute spaces between rocks. This must drain out slowly to lower points, usually where the bottom of a drilled well is located.

feet in height, mounted on it. A cable (B) runs over a pulley (C) at the top of this tower and comes down one side to a power drum (D), and the other to a bit. The cable at (B) raises and drops the bit by action of rocking beam (E).

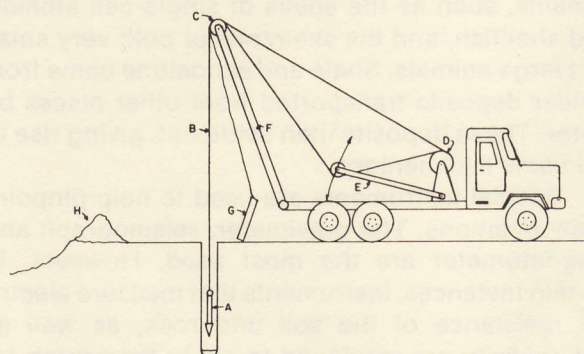


Fig. 3.—Diagram of a cable drilling rig.

The bit (A) is heavy. Different sizes and shapes are available for going through various earth formations. The machine raises, then drops this bit over and over, thus punching a hole in the earth by pulverizing rocks and earth. When a depth of pulverized material impedes or cushions the bit, it is

raised by the drum, and several buckets of water are poured down the hole. This soaks up the pulverized material and holds the small particles in suspension. A special tube called a bailer (G) with a valve in the bottom, is lowered into this liquid. The bottom valve is then closed and the liquid, with the earth particles, is lifted out and dumped aside (H). This process is carried out many times until the hole reaches the desired depth. Cable drilling is comparatively cheap but is slow and cannot reach the great depths needed today.

Rotary Drilling

Rotary drilling is complex and expensive; however, the principle of operation is simple. The operation is similar to a person boring a hole in wood or metal with a drill press. A schematic diagram of some of the essential parts of the boring mechanism is shown in Figure 4.

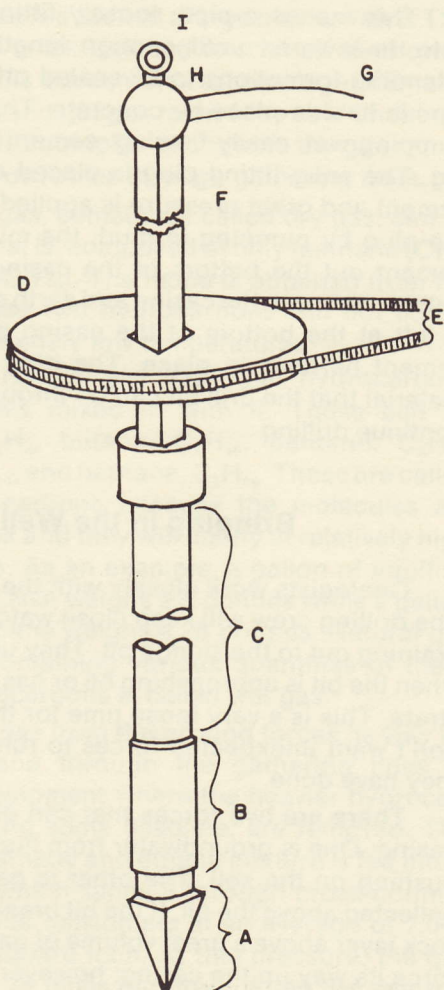


Fig. 4.—Rotary drilling equipment.

The hollow square-shaped kelly (F) is driven around and around by the rotating table (D) and at the same time can slide up and down through the square hole in the rotating table. It is driven by a large chain (E) or gears connected to transmissions on diesel engines. The kelly has a swivel connection (H) at the top to allow liquid to be pumped down the drill pipe to flush out cuttings (G) made by the bit. It also has a lifting eye (I) that allows connection with the hoist which can lift many tons of weight to change the pipe or the amount of weight to be put on the bit. In very deep holes this load can exceed 100 tons.

Immediately below the rotating table and at the end of the kelly is the connection for the drill pipe. Extra lengths of drill pipe, in 30 foot lengths (C) are added as the hole deepens. At the end of the drill pipe is the drill stem (B) which is simply a connection between the various bits (A) and the drill pipe. Bits can drill holes of various sizes from six to 20 inches.

A diagram of the overall drilling machine is shown in Figure 5. The rotating table (D) is mounted in the floor of the derrick on heavy bearings (N). It can be rotated by large chains or gears which are in turn connected to large diesel engines (I) equipped with clutches, brakes and transmissions. Rotation speeds vary from 50 to 300 rpm. Slow speeds are used when drilling hard rock.

As the bit (A) cuts a hole (B) through various materials in the earth (P) by shaving or grinding the material into small particles, a special liquid called mud (K) is forced into a hose (L) by pump (M). It

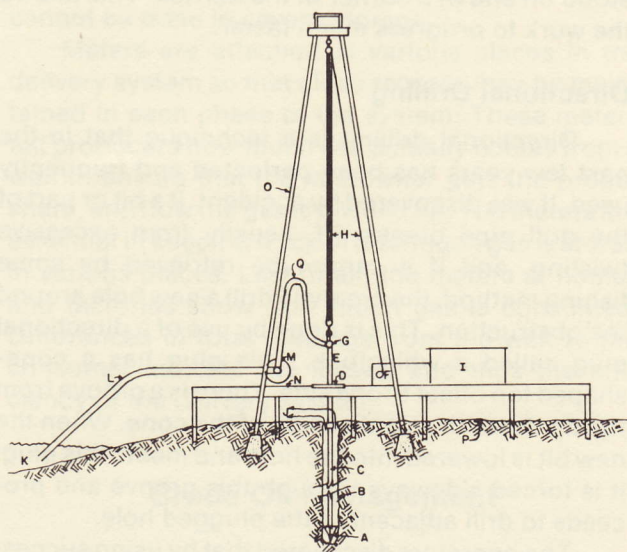


Fig. 5.—Rotary drilling rig.

then is forced through hose (Q) and swivel (G) where it goes down the drill pipe and is forced out through openings in the drill bit. Here it flushes the particles back up the drilled hole on the outside of the drill pipe. At the top of the hole this liquid is discharged into the sludge pit where the earth particles settle out (K). Some of the particles are occasionally caught and examined to determine what type of earth strata the bit is going through.

When the bit has worked its way into the earth so that the top of the kelly nears the rotating table, the operator stops the table. With the winch (F) and cable he lifts the drill pipe and bit until the bottom of the kelly is just above the rotating table. In this position, special clamps hold the drill pipe while the kelly is unscrewed, raised, and a new section of 30 foot drill pipe is inserted at C. The winch then lowers the drill pipe until the bit rests on the bottom of the hole, and the square kelly is again engaged in the square hole of the table. The rotating engine is engaged and drilling continues. The weight of all the drill pipe must be carried by the tower (O) and the supporting cables (H). Special gauges indicate the weight on the bit and rate of drilling. The average time a crew needs to add a new section of drill pipe is about 1 minute.

When a bit becomes worn and needs replacing or when the bit enters a new formation for which it is not suited, a change of bits is required. This entails lifting all drill pipes to get at the drill stem and change the bits. This operation is similar to adding the 30 foot lengths of drill pipe except that if the derrick is tall enough, two or three sections of the 30 foot drill pipe can be unscrewed at one time and stood on end in a corner of the derrick. This allows the work to progress much faster.

Directional Drilling

Directional drilling is a technique that in the past few years has been perfected and frequently used. It was discovered by accident. If a bit or part of the drill pipe breaks off, usually from excessive twisting, and if it cannot be retrieved by some fishing method, the crew will drill a new hole around the obstruction. This is done by use of a directional plug called a whipstock. This plug has a cone-shaped top offset to one side. There is a groove from the tip down the slanted side of the cone. When the new bit is lowered into the hole and meets this plug, it is forced sideways through this groove and proceeds to drill adjacent to the plugged hole.

The operators discovered that by using successive plugs or whipstocks they could gradually direct

a bit many feet off to the side in a gradually curving hole. Many wells on shore can reach out under water and tap oil and gas pools that are thousands of feet away.

This method is used on offshore rigs to allow several holes to be sunk from the same platform. This helps reduce the cost per hole of the extremely costly platform. Directional drilling is also used to sink a new hole beside one that has caught fire. The new hole can allow gas to pass through it and lower the pressure in the old hole so that the fire can be controlled. It also is used to plug the old hole to stop the flame.

Casing the Hole

Frequently the drilled hole passes through earth formations that are rather soft and tend to cave in, or passes through groundwater that must be kept out. In these instances, the hole must be cased.

This means a pipe, loosely fitting the drilled hole, is lowered until enough length allows the offending formations to be sealed off. The casing pipe is held in place by concrete. This is done by pumping wet, easily flowing cement into the casing. The snug-fitting plug is placed on top of the cement and great pressure is applied to the top of the plug by pumping in mud; the mud forces the cement out the bottom of the casing and up the outside between the casing and earth side. The plug is left at the bottom of the casing pipe until the cement hardens in place. The plug is of such a material that the drill bit can go through it easily to continue drilling.

Bringing in the Well

Geologists work closely with the drilling crew. The drilling crew will keep close watch on the mud draining out to the sludge pit. They usually can tell when the bit is approaching oil or gas formations or strata. This is a very tense time for the crew. They don't want unexpected forces to ruin all the work they have done.

There are two forces that can drive oil up the casing. One is groundwater from higher elevations pushing on the soil. The other is gas that can be collected above the oil. If the bit breaks through the rock layer above a great volume of gas, this gas can force its way up the casing; however, the crew has made preparation for this. Special valves and

gauges attached to the casing are already in place and can be automatically closed to contain the oil or gas under pressure.

Sometimes the gas is dissolved in the oil and exerts very little pressure. These wells must be pumped. Machinery similar to water pumping equipment is often used.

Very seldom is a high-pressure well allowed to run away or blow out. This is dangerous as well as very wasteful. A large percentage of the oil wells require pumping, so there is little danger or loss.

Natural Gas Management

Natural gas is always under pressure in the ground, sometimes at several thousand pounds per square inch. It forces its way to the earth's surface through the man-made hole. The casing pipe, that was cemented in place, is the conduit through which the natural gas is guided to the surface. At the top of this pipe is attached a large master valve. This valve can be quickly closed to shut off the flow of gas. Above this is a complex assemblage of smaller pipes, valves and gauges referred to as a Christmas Tree. From this complex of controls the gas can be sent on various routes through gathering lines.

Natural gas, sometimes called dry gas, can be quite pure; that is, composed of only methane (CH_4) and ethane (C_2H_6). The name is obtained from the fact that these two hydrocarbons will not liquify unless at extremely low temperatures.

Usually natural gas has other hydrocarbons and chemicals mixed in with it. These can be propane, C_3H_8 , butane, C_4H_{10} , pentane, C_5H_{12} , hexane, C_6H_{14} , and heptane, C_7H_{16} . These are called heavy hydrocarbons because the molecules are more complex and they will liquify at relatively high temperatures. As an example, a gallon of liquified natural gas, LNG, weighs 2.5 pounds while a gallon of liquid propane weighs 4.25 pounds. Natural gas from wells containing various quantities of these heavier hydrocarbons is called wet gas.

The raw gas from the ground forces its way up the casing and through the gathering lines to extraction equipment where the heavier hydrocarbons, including some gasoline, are removed. The remaining methane and ethane mixture is fed into a compressor which sends it through cross-country lines to various consumers at an average of 1,000 pounds per square inch. At this pressure, the gas travels about 15 miles per hour. When the demand for the gas is heavy, such as prolonged cold

weather, the pressure can be increased to 4,000 to 5,000 pounds per square inch which about doubles the delivery volume.

Natural gas may be stored in underground caverns near large cities if the cavernous area has been proven to be gas tight. These large volumes of gas act as buffers or surge dampers for any sudden large loads that might be required by the consumer.

Gas also can be stored in large, above-ground, man-made tanks. The gas is cooled by refrigeration to -260°F . At this low temperature it is in liquid form; 630 cubic feet of gas will occupy only 1 cubic foot of volume. The natural gas itself is used as the cooling medium or refrigerant, the same as freon is used in home refrigerators. Very large horsepower engines, usually gas turbine types that burn natural gas, drive compressor pumps, thus increasing the pressure on the gas many times. This highly compressed gas gets very hot and is cooled by large radiators. This gas then is allowed to expand inside another radiator causing the radiator to become very cold. The rest of the natural gas is pumped through this cold radiator and lowers its temperature. This cycle is repeated in three stages so that the final gas temperature is -260°F and condenses to a liquid. There is no pressure exerted on the tank when in the liquid form. It is nearly impossible to compress natural gas enough to force it into liquid form, and that's the reason for the cooling process.

Even though the storage tank is insulated, the liquid gas needs to be continually cooled to keep it at the -260°F level. It therefore takes some of the fuel in the engines driving the refrigeration equipment to keep the gas in a liquid state; but all the gas can be recovered from the storage tank which cannot be done in cavern storage.

Meters are attached at various places in the delivery system so that close records may be maintained in each phase of the system. These meters tell producers how much gas actually comes from a well to ensure that the landowner gets the proper share, and how the gas is divided up. The meters are essential in keeping track of how much gas is stored in various places. Last of all, the meters at homes and factories show how much gas is consumed. Differences in total readings from the well to the consumer indicate the losses, and thus the efficiency of the delivery system.

Crude Oil Management

Oil also may be brought to the surface by natural pressure. This pressure may be supplied

by some natural gas trapped in pockets above the underground pool of oil. Sometimes, groundwater pushes on the trapped oil. Most oil wells, however, reach down to pools of oil or into oil saturated sand which has no pressure on it; these wells must be pumped.

Engineers describe the removal of oil from the earth as a displacement process. The oil molecules do not have the ability to move themselves like the natural gas molecules do. The oil must be pushed to the drilled hole. If gas or water pressure is not available, the well may be drilled deeper than the oil bearing formation, and gravity will cause the oil molecules to run down to the well where they accumulate and are lifted by pump to the surface.

Artificial or man-made pressure can be used to help push the oil from the formation toward the well. Natural gas, water or sometimes steam can be pumped down adjacent wells to force the oil in the desired direction. Steam can serve a double purpose. It can apply the pressure and can heat the crude so that it flows more easily. It is easy to see the extra costs involved in having to apply some of this assistance.

Many wells will flow under natural pressure for a time and then begin to dwindle and eventually stop. From this time on, artificial means must be employed, usually pumping, to bring the oil up. The most common type of pump is the piston, rod and rocker arm shown in Figure 6. Submersible pumps

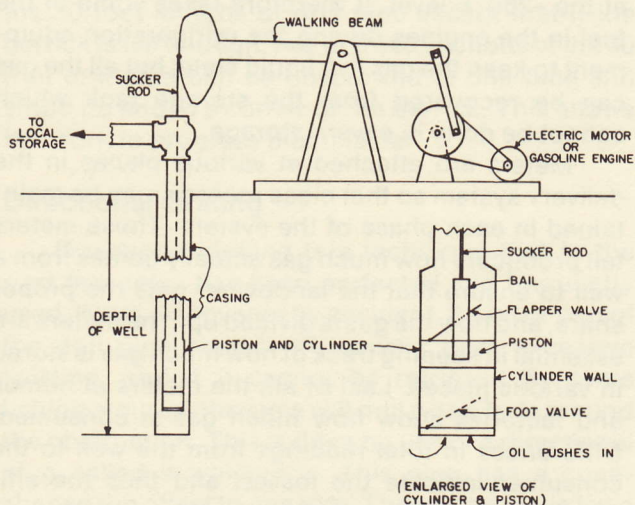


Fig. 6.—Diagram of an oil well pump. The sucker rod extends through the sealed cap valve at the top of the pipe to the bottom of the well where the cylinder, valves and piston are located. The sucker rod lifts oil that is retained above the piston to the surface. The cylinder must be immersed in crude oil, thin and deep enough to flow through the foot valve and fill the space above the piston before the piston starts its upward movement.

are used in some places. The pump and the attached electric motor are lowered to the bottom of the hole, immersed in the oil with electric power provided by a long extension cord. Oil pumping equipment is quite similar to that used to pump water.

Stripper wells are usually older and produce only a few barrels per day. They can be pumped only a short time each day. Intermittent pumping allows oil from the cracks and crevices of the oil-bearing rock or sand formations to drain into the bottom of the well. There are several thousand such stripper wells in the United States today which produce about 15 percent of our crude oil needs.

The life of an oil or gas well begins when the first raw products pass the master valve at the top of the casing. The well's life ends when it is abandoned because its products are uneconomical to obtain. This happens when the cost of production is greater than the price received. The life of any well varies and can be less than a year to more than 50 years. Some petroleum engineers have estimated that one-third to one-half of the original crude is still in the ground and cannot be removed economically by any of today's methods.

When it is determined that a well is to be abandoned, the surrounding area is cleaned up, and the slush pits are covered deeply. Then the site is regraded and resodded or planted with native vegetation. The drilled hole itself often is plugged with cement at several different levels to protect ground water. All equipment is removed, and often with the regrowth of vegetation, it is very difficult and maybe impossible for a layman to find the well's former location. Of course, records are kept of the exact location, and surveyors could find it if necessary.

Refining Oil

Usually the first stop for the crude oil after reaching the top of the well is a nearby storage tank. When convenient, it is moved by pipeline, tank truck, rail tanker, barge or ocean tanker to a refinery for processing. There it is put in local storage tanks.

A refinery is a complex plant where the crude oil is processed into many products. Some of these are gasoline, diesel oil, lubricating oil and road-forming asphalt (Figure 7).

The crude oil is made up of many hundreds of combinations of carbon and hydrogen called hydrocarbons. The fact that these various combinations vaporize at different temperatures makes the operation of the refinery possible. The refining process is

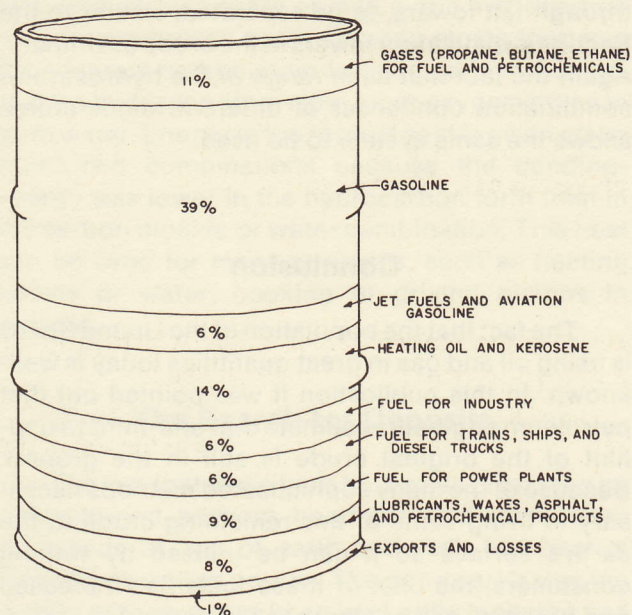


Fig. 7.—Approximate quantities of various products obtained from a barrel of petroleum that has been processed in a refinery.

actually distillation. This is a process which extracts a gas or vapor from a liquid. In theory, it is actually quite simple. A kettle of boiling water on a stove is an example. The steam from the water is pure water; all minerals and solids are left behind in the bottom of the kettle. When the steam is allowed to touch a cool surface it condenses, that is, returns to the liquid state again and can be collected by allowing the liquid water to drop into a container. One then has pure water which is called distilled water.

A laboratory setup for distilling liquids is shown in Figure 8. The distillation process actually includes two steps, vaporization and condensation. In

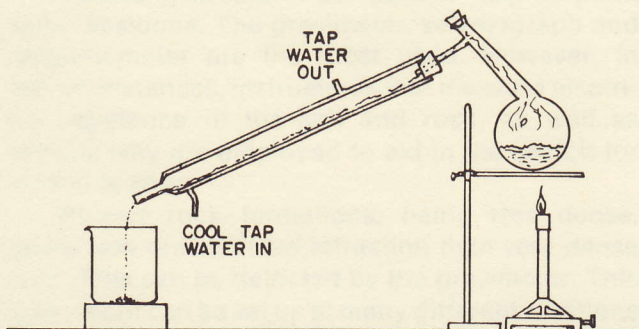


Fig. 8.—Laboratory equipment set up for distillation of a liquid. Distillation means to drive vapors from liquids by heating the liquid, then condensing the vapors back to liquid by cooling.

nature the same process takes place by water evaporating from exposed water surfaces, such as the oceans, lakes and rivers, and returning as precipitation in the form of snow, water or dew.

The crude oil is taken from the refinery storage tank by pipe and pumped toward the distillation towers (Figure 9). Here it enters a furnace which is fired by gas taken from the refinery. The first fractions or components of the crude to evaporate are those hydrocarbons composed of the lightest molecule, which is propane, C_3H_8 . These vapors travel up the tower to the top. Next to evaporate is butane, then gasoline, kerosene, jet fuel, diesel fuel and light lubricating oil. At the lower end of the tower the heaviest lubricating oils and greases are extracted, and at the very bottom the heavy products, such as asphalt are removed. The heat of the furnace is kept on until all the crude has evaporated, and these vapors have entered the tower.

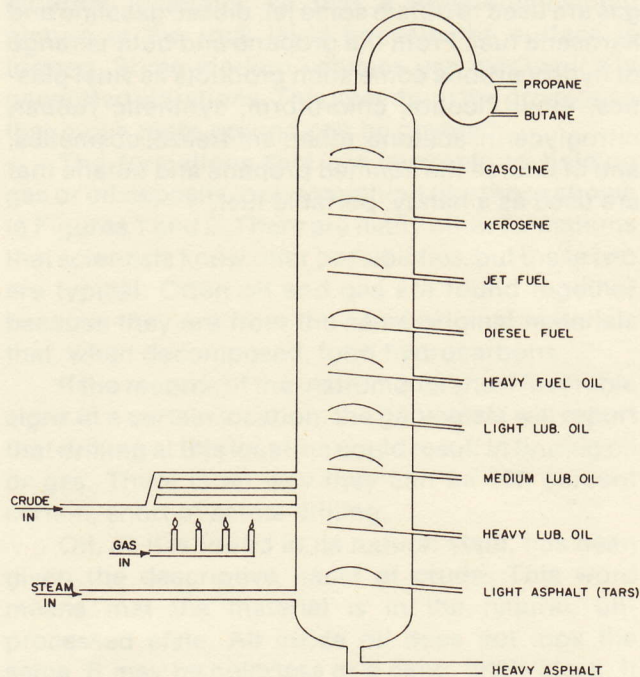


Fig. 9.—Fractionating distillery tower in a refinery. The gas and steam come from the plant. The temperature in the furnace keeps increasing until all the crude oil has evaporated.

Modern refineries operate on a continuous flow method, that is, the crude flows at a constant rate into the furnace. The components that make up the crude are discharged at a continuous rate from the various exits where they have condensed. Thus, the crude is separated into the various parts shown in Figure 9.

Petrochemicals

The aspect of natural gas processing and oil refining that deals with products other than those used for fuel is called petrochemical processing. The wide range of products themselves are called petrochemicals. The petrochemical industry accounts for 8 to 10 percent of the oil and natural gas consumed in the United States each year.

Natural gas from the well usually contains many valuable combinations of hydrocarbons other than the CH_4 and C_2H_6 (dry gas). The CH_4 is used mainly as fuel for homes and industry. Even the dry gas furnishes some products, such as carbon black for ink and formaldehyde for use in plastics and dyes. Proper processing is of course necessary to obtain these useful products. Many careers are waiting for the highly trained person who understands these procedures.

Heavier hydrocarbons taken from the natural gas are used to obtain some jet, diesel, gasoline and kerosene fuel. From the propane and butane range of hydrocarbons come such products as vinyl plastics, ethyl alcohol, chloroform, synthetic rubber, nitroglycerin, acetone, ether, antifreeze, cosmetics, and of course the liquified propane and butane that are used as a handy, portable fuel.

All the products taken from natural gas go through tall towers, to be separated, similar to the fractional distillation towers in the crude oil refinery. Again the fact that each range of the hydrocarbon combination condenses at different temperatures allows the same system to be used.

Conclusion

The fact that the population of the United States is using oil and gas in great quantities today is well-known. In this publication it was pointed out that petroleum engineers estimate that one-third to one-half of the original crude is still in the ground. Because of the many sophisticated methods necessary to bring some of this remaining crude to the earth's surface so it can be utilized by waiting consumers, the cost of these fuels has increased and probably will continue to increase.

The consuming public should be aware of the possible end to these non-renewable fuels and apply conservation methods. This will extend the life of fossil fuels, giving us time to develop other types of fuel.

Questions

To stimulate thought and greater understanding, answer these questions with the best word(s) to make a true statement. Refer to the material when necessary.

1. Scientists today know exactly how oil and gas were formed. (True or False) _____
2. Natural gas is being formed today. (True or False) _____
3. The natural gas formed today is of economic value to us. (True or False) _____
4. What is the initial source of energy input into our fossil fuels? _____
5. What two enormous events were necessary to form the abundance of gas or oil? _____

6. What do farmers do today that is similar but on a smaller scale? _____

7. Are bacteria always present on living plants? (Yes or No) _____
8. Coal is very close kin to oil and gas. (True or False) _____
9. What is the main difference between oil and gas and coal? _____

10. Coal, oil and gas come from the same organic family called _____
11. A molecule of hydrocarbons contains what two elements? _____
12. Why are hydrocarbons called fuels? _____
13. What two groups of people are skilled at locating possible sources of oil and gas? _____
_____ and _____
14. Name three instruments used most by geologists in their work. _____

15. Oil and gas are only found in sedimentary rock. (True or False) _____
16. All crude oil looks the same. (True or False) _____
17. What two mechanical methods are used to drill holes in the earth? _____
18. Rotary equipment is more complex than cable equipment. (True or False) _____
19. Each piece of drill pipe is 30 feet long. (True or False) _____
20. The weight of the drill pipe in deep wells can be over 100 tons. (True or False) _____
21. The liquid that is used to flush the cuttings out of the drilled hole is called _____

22. The lifting winch serves two purposes. One is to lift the pipe to add or take out the 30 foot length of drill pipe, and the other is to adjust the load on the drill bit. (True or False) _____
23. Rotation speeds of the bit can vary from _____ rpm to _____.
24. The direction or slant of a hole can be changed by using directional plugs called _____.
25. Directional drilling allows a rig on shore to reach out under water and tap oil sources. (True or False) _____
26. The drilling crew is usually alert to approaching oil or gas bearing strata. (True or False) _____
27. Casing pipe is used to seal out ground water and to support earth that continually caves in. (True or False) _____
28. Gas always forces its way to the surface, but oil always has to be pumped. (True or False) _____
29. The drilling crew is usually ready to deal with expected high pressure gas by attaching various control valves and gauges at the top of the pipe. This assembly of pipes and valves is called a _____.
30. Pure, natural gas (dry gas) is made up entirely of two gases, _____ and _____.
31. Natural gas can be stored in underground, cavernous areas. (True or False) _____
32. Storage of natural gas can be economically accomplished in strong, high pressure tanks. (True or False) _____
33. What temperature must natural gas be cooled to before it condenses to a liquid? _____
34. Do all oil wells require pumping? (Yes or No) _____
35. Why are wells abandoned? _____
36. What is the purpose of a refinery? _____
37. Distillation is the process used in a refinery. (True or False) _____
38. What fact makes the refining process possible? _____
39. All products, other than fuel, obtained from the gas from wells are called _____

Answers

- | | |
|---|---|
| 1. F | 21. mud |
| 2. T | 22. T |
| 3. F | 23. 50, 300 |
| 4. sunlight | 24. whipstock |
| 5. plants and upheaval of earth's crust | 25. T |
| 6. place green plants in a silo | 26. T |
| 7. yes | 27. T |
| 8. T | 28. F |
| 9. more animal remains in oil and gas | 29. Christmas Tree |
| 10. hydrocarbons | 30. methane and ethane |
| 11. hydrogen and oxygen | 31. T |
| 12. They will burn. | 32. F |
| 13. geologists and geophysicists | 33. -260°F |
| 14. magnetometer, seismograph, gravimeter | 34. no |
| 15. T | 35. not economical |
| 16. F | 36. to process crude into products |
| 17. cable and rotary | 37. T |
| 18. T | 38. Parts vaporize at various temperatures. |
| 19. T | 39. petrochemicals |
| 20. T | |

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